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ELECTRICAL PRINTING METHOD WHICH CHANGES IMAGE SIZE DURING POWDER TRANSFER

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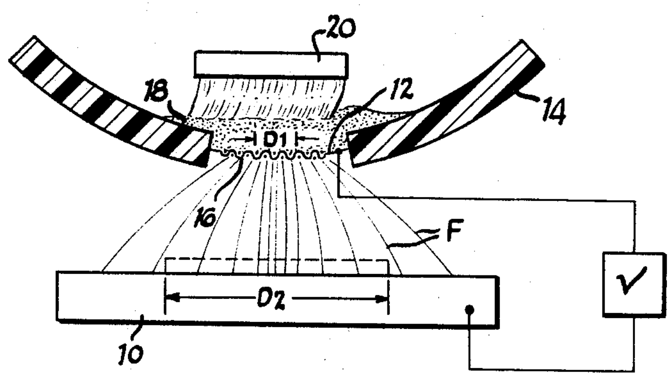

FIG. 1

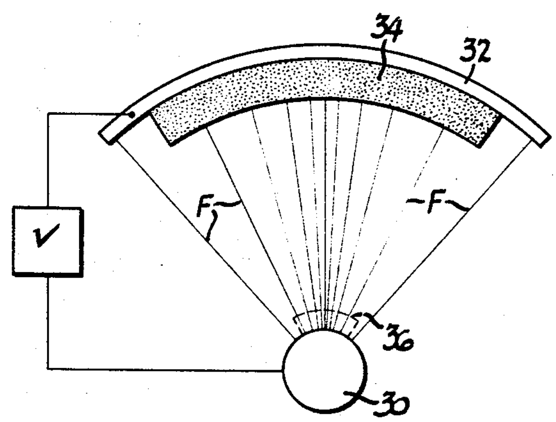

FIG. 2

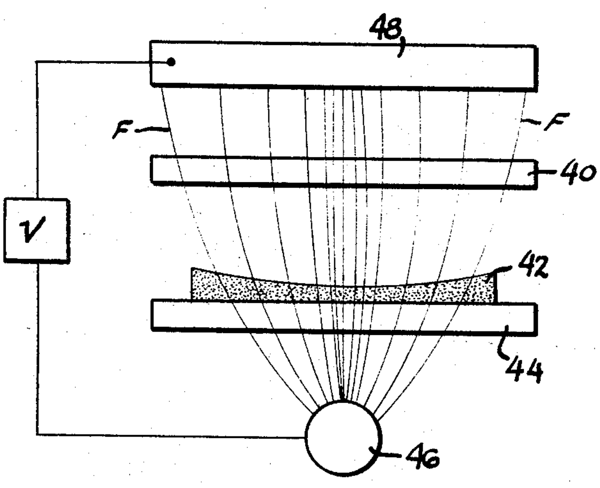

FIG. 3

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ELECTRICAL PRINTING METHOD WHICH CHANGES IMAGE SIZE DURING POWDER TRANSFER

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ABSTRACT OF THE DISCLOSURE

Methods for electrically transferring powder shaped images from an article or supply of printing powder particles in which the shape or size of the image may be modified during the transferring operation.

It is one object of the present invention to provide a method by which printing powder particles may be transferred from a powder supply in which the powder is disposed in an image-shaped area to an article surface in which the image may be enlarged or contracted during the transferring operation.

It is another object of the invention to provide a method for electrically transferring printing powder particles from a supply to an article surface in which the density of the resulting image may be varied as desired.

Other objects and features of the invention will become apparent by reference to the following specification and to the drawings.

In the drawings:

FIGURE 1 is a schematic view, partially in cross section, showing one form of the present invention;

FIGURE 2 is a schematic diagram of another exemplary form of the invention;

FIGURE 3 is a schematic view of still another form of the invention.

In FIGURE 1, an article surface which is to be decorated is schematically illustrated at 10 and is supported by suitable means, not shown, in vertical registry beneath an electrically conductive wire mesh stencil screen 12 supported within a suitable mounting 14 of electrically non-conductive material. The screen 12 and mounting member 14 are of a curvature, as shown, wherein the center of curvature is above the screen on FIGURE 1. Stencil screen 12 is of a coated wire mesh in which the coating fills the mesh openings except within a selected area from which the coating has been removed to define an image-shaped aperture 16 in the screen. For suitable materials and methods for preparing such a screen see Patent No. 3,100,150.

The aperture 16 in FIGURE 1 is shaped in accordance with the desired configuration of the image which is to be applied to article 10. The size range of particles within bed 18 is chosen to be such that the particles will normally clog the mesh openings within image aperture 16 so that particles will not ordinarily pass downwardly through the mesh openings unless they are mechanically forced through by a brushing action applied by movement of a brush 20. Normally, the mesh openings within image aperture 16 are substantially filled with powder particles so that, within the general surface of the screen, there exists a layer of powder particles having an image-shaped outline determined by the edges of aperture 16.

During the decorating operation a source of electric potential designated generally V is electrically connected to screen 12 and to article 10 to electrically charge the screen and article surface to different electric potentials.

In the FIGURE 1 embodiment, the overall area of the electrically conductive screen 12 is substantially smaller than the overall area of the opposed surface of article 10.

When the screen and article surface are charged to different electric potentials, an electric field is established within the space between screen 12 and the article surface, these two elements acting as electrodes or equipotential surfaces of the electric field. Because of the differing area the electric field thus established is of a non-uniform configuration in that the lines of force F are arranged in configurations illustrated in FIGURE 1 in which the lines of force diverge from each other in their extent from screen 12 to the surface of article 10.

A line of force of an electric field may be defined as a curve so drawn as to have everywhere the direction of the electric intensity. Thus, an electric charge introduced in an electric field tends to move along a path defined by the lines of force.

In the FIGURE 1 embodiment, as particles are mechanically expressed through the mesh openings of screen 12 by operation of brush 20, the particles become electrically charged by virtue of their electric contact with the wire mesh of the screen. As the particles move below screen 12, the particle which is charged to a like polarity compared to the potential of screen 12 becomes repelled downwardly from screen 12 and attracted toward article 10. The path along which the particle will tend to move is determined by the lines of force F.

In FIGURE 1, the lines of force diverge in their extent from screen 12 to article 10 and hence particles passing downwardly through the field likewise tend to diverge from each other, thereby resulting in a magnified or enlarged image being applied to article 10.

In addition to the simple magnification referred to above, the arrangement of FIGURE 1 also permits the achievement of a shaded image. For purposes of explanation, it is most convenient to assume that article 10 is in the form of a flat circular disc and screen 12 and its image aperture 16 are circular in shape, the article, screen and aperture being coaxially centered upon a common vertical axis. With the arrangement of FIGURE 1, assuming the diameter of image aperture 16 to be indicated at D1, the resulting image on article 10 might have an overall diameter as indicated at D2.

However, the density or thickness of the layer of powder particles transferred to article 10 would not be uniform, but would be thicker or more dense at the center with the density diminishing in the radial outward extent from the center. This is because the number of lines of force emanating from the area of the image aperture is the same as the number of lines of force reaching the article surface within the area of the image—i.e. the circular area of diameter D2. Further, the electric intensity is more concentrated over that region in which the two equipotential surfaces are closest to each other and hence the flux density—i.e. number of lines of force per unit area—is highest in the center and diminishes with increasing radius from the center of disc shaped article 10. Particles travelling from screen 12 to the surface of the article are most strongly guided by those portions of the field in which the flux density is highest, and thus particles are more firmly constrained to follow the lines of force toward the center of the image area.

Other effects may be produced by varying the shape of screen 12 and article 10. For example, assuming a square screen and a rectangular article, the image produced on the article could be proportionately elongated longitudinally of the rectangular article.

In FIGURE 2, another exemplary form of the invention is disclosed which includes a first electrode 30 and a second electrode 32, the two electrodes being of cylindrical configuration and located in concentric relationship to each other. In the embodiment of FIGURE 2, a powder supply bed 34 is shaped in the form of an image-shaped layer of particles upon the surface of electrode **32**. Electrode **30** is defined by the article which is to be decorated which might, for example, be a bottle or cylindrical container. An electric potential source V is electrically connected to the article **30** and to electrode **32** to charge the respective elements to different electric potentials, thereby establishing an electric field having lines of force F which extend in radial directions with respect to the axis of the cylindrical article **30**.

In FIGURE 2, the image-shaped layer or supply bed is reduced in size upon its transfer to article **30**. In this particular instance, it may be noted that the reduction in size occurs only in the circumferential extent of the image because the lines of force, if viewed in a radial cross sectional plane extend parallel to each other. The arrangement of FIGURE 2 is convenient when it is desired to achieve a dense image from a relatively thin powder supply area.

It is believed apparent that the embodiment of FIGURE 2 could equally well be operated in a reverse sense by initially disposing an image-shaped layer of printing powder particles upon element **30** for transfer to electrode **32** in the form of a circumferentially magnified image.

In many cases, the article being decorated does not have electrical resistivity characteristics within the range which adapts the article for use as an electrode of the electric field. In FIGURE 3, an exemplary embodiment is disclosed in which the article being decorated is indicated at **40**, the article being of an electrically non-conductive material. An image-shaped layer of printing powder particles **42** is supported upon a second non-conductive element **44** for transfer to the surface of article **40**. In this case, a spherical electrode **46** is located beneath powder bed support **44** while a flat electrode **48** is mounted at the side of article **40** remote from powder bed **42**. An electric potential source V is electrically connected to electrodes **46** and **48** to establish the electric field. In the FIGURE 3 embodiment, particles within supply bed **42** are electrically charged prior to the application of the electric field. The lines of force F in the electric field of the FIGURE 3 embodiment diverge from each other so that a magnified image is formed upon the lower surface of article **40** upon the transfer of powder from support **44** to the article. To counteract the non-uniform distribution referred to above in connection with the FIGURE 1 embodiment, the powder bed **42** of the FIGURE 3 embodiment may be somewhat thickened at its edges to compensate for the decreased image thickness in this region. Alternatively, a uniform image may be achieved in the FIGURE 3 embodiment by constructing electrode **48** as a spherical surface concentric with the center of spherical electrode **46**.

While various embodiments of the invention have been described, it will be apparent to those skilled in the art that the disclosed embodiments may be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting, and the true scope of the invention is that defined in the following claims.

I claim:

1. The method of applying an image-shaped layer of printing powder particles to an article surface comprising the steps of positioning a supply of printing powder particles disposed within a first area having the shape of the desired image to be applied to the article, between an article surface to which said layer is to be applied and a spherical electrode, establishing an electric field having lines of force extending from said spherical electrode throughout a second area in said powder supply encompassing said first area to a third area upon said article surface larger than said second area whereby the lines of force diverge from each other in their extent from said second to said third area, and electrically charging particles in said powder supply to electrically transfer said particles through said field from said supply to said article surface along divergent paths defined by said lines of force.

2. The method of applying an image-shaped layer of powder particles to an article surface comprising the steps of locating a pair of electrodes of different effective areas in spaced opposed relationship to each other whereby upon application of an electrical potential difference to said electrodes an electric field is established in which the electric lines of force diverge from each other, locating an article surface to which an image is to be applied in spaced relationship to an image-shaped layer of powder particles with said layer and said surface being located between said electrodes and extending transversely of the paths of the lines of force of the electric field, and applying an electric potential difference to said electrodes sufficient to electrically impel the image-shaped layer of particles to the article surface with the particles following the paths of the lines of force of the electric field to thereby apply to the article surface an image-shaped layer of particles in a similar shape and of an overall size differing from that of the original layer prior to its transfer in accordance with the divergence of said lines of force.

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